Docket No.: 2328-053 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	
Tuquiang NI et al.	:	Confirmation No. 5171
U.S. Patent Application No. 09/821,753	:	Group Art Unit: 1763
Filed: March 30, 2001	:	Examiner: Luz L. ALEJANDRO

For: PLASMA PROCESSING METHOD AND APPARATUS WITH CONTROL OF PLASMA EXCITATION POWER

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF ANDREW D. BAILEY III, Ph.D.

I, Andrew D. Bailey III, Ph.D., hereby declare as follows:

1. Exhibit 1, submitted with my Declaration filed in the U.S. Patent and Trademark Office on June 9, 2006, is an accurate statement of my education, work experience, honors, publications, presentations and abstracts and issued United States Patents. As part of my work experience, I have worked closely with those of ordinary skill in the art relating to plasma processing of workpieces and have supervised many persons of ordinary skill in the art in the plasma processing of workpieces. As a result of my work experience, I am knowledgeable of those of ordinary skill in the art in the plasma processing of workpieces. I am also regarded by my peers as an expert in the technology relating to plasma processing of workpieces. Many of the publications listed in Exhibit 1 are publications in refereed journals, and as such, were subject to peer review prior to publication.

2. I have carefully read the referenced application as filed, the claims I understand attorney for applicants plans to submit with this Declaration in the referenced application,

the Office Action of March 9, 2006, and the Bhardwaj et al. reference, USP 6,051,503, primarily relied on in the Office Action.

3. My review of the referenced application, as originally filed, finds support for the requirement of claims 46 and 58 for "the AC etchant plasma always being the dominant material applied to the workpiece while the desired shape is being formed."

(a) Page 5, lines 26-28 and claim 8, page 19 indicate that, in the preferred embodiment, a gas species is ionized into a plasma that etches the material and that the preprogrammed gradual power change and the species are such that the material is shaped so a rounded corner is formed in the material as a result of the etching. This statement enables one of ordinary skill in the art to understand that in one embodiment the desired shape is the rounded corner. One of ordinary skill in the art would understand from the statement that an AC etchant plasma is always the dominant material applied to the workpiece while the rounded corner is being formed. Otherwise, etching of the workpiece to obtain the rounded corner would not have occurred. One of ordinary skill would understand that if an etchant gas were not always dominant, e.g., if a passivation gas or a dilutant gas were dominant, the rounded corner of Fig. 6 could not have been formed.

(b) Page 16, line 23-page 17, line 2 states microprocessor 201 has a memory system that performs the final etch operation for 15 seconds. The final etch operation causes formation of a predetermined shape, e.g., a rounded edge 216 between point 212 and base 214. During the 15 second final etch operation a suitable mixture of HBr/O_2 constantly flows from source 68 into chamber 40 while the power that amplifier 132 supplies to electrode 56 gradually changes from 200 watts to 100 watts. One of ordinary skill in the art would interpret such a statement to mean that the etchant HBr is always dominant over the O_2 passivation gas during the 15 second etch operation. One of ordinary skill in the art knows that if the etchant gas HBr and the passivation gas O_2 both constantly flow to a chamber to perform an etch operation, that the etchant gas HBr must always be dominant over the passivation gas O_2 during that etching operation. Otherwise,

material in the passivation gas would be deposited on the workpiece and would have a greater effect on the material being worked than the etchant gas. As a result, the rounded corner, i.e., edge, illustrated in Fig. 6 would not have been formed.

4. I do not agree with the statement in the March 9, 2006, Office Action that Bhardwaj et al. discloses converting a gas species into an AC etchant plasma that is either the dominant material or the only material that is continuously applied to a workpiece while a feature of the workpiece is being formed.

(a) The specification and each of independent claims 1, 29, 30 and 31 of Bhardwaj et al. are concerned with a method of forming a feature in a semiconductor substrate. To form the feature, the substrate is subjected to a cyclical process including plural successive process cycles. Each of the successive process cycles includes a first process of reactive ion etching and a second process of depositing a passivation layer by chemical vapor deposition.

(b) Based on the foregoing, it is clear to me, as an expert in the technology, that Bhardwaj et al. does not disclose converting a gas species into an AC etchant plasma that is either the dominant or only material that is continuously applied to a workpiece while a desired shape in the workpiece is being formed. The entire thrust of the Bhardwaj et al. patent is to form a feature, e.g., a trench, by alternately etching and depositing materials, as indicated, for example, by the waveforms of Figure 7, wherein the first, fourth and seventh columns are associated with etching, the second and fifth columns are associated with deposition, and the third and sixth columns are associated with pump out of gases. Figure 7 indicates that during the etch steps, the coil power and the bias power remain constant and that the coil and bias power also remain constant during the deposition steps. The waveforms of Figure 9(i) and 9(ii) indicate bias power changes abruptly between the etch and deposition steps. The RF bias is high during the deposition steps when pressure is low, and is low during the etch steps, when pressure is high. Column 9, lines 47-51 indicates the bias changes from low to high as the cycle changes from deposition to etch, respectively, in synchronism with pressure changes from low to high. These alternate

etch and deposition steps occur during formation of a feature, particularly a trench wall, as discussed in column 1, lines 4-13 and as set forth in Bhardwaj et al.'s independent claims.

(c) The discussion in Bhardwaj et al., column 8, line 27-column 9, line 34 indicates the importance Bhardwaj et al. ascribed to the alternate etching and deposition steps to form a feature. This portion of Bhardwaj et al. indicates the problems associated with the prior art, as represented by Figure 3, in forming a silicon trench only by etching. The paragraph bridging columns 8 and 9 is particularly relevant because it discusses the importance of the passivation, i.e., deposition, step.

(d) Based on the foregoing, Bhardwaj et al. does not form a desired shape of a workpiece by converting a gas species into an AC etchant plasma that is always the dominant material applied to the workpiece while the desired shape is being formed, wherein the amount of AC power applied to the plasma during etching of the workpiece to form the desired shape gradually changes and a gradual transition in the shape of the material in the workpiece being processed occurs in response to the gradual power change that occurs during the gradual transition in the shape of the material. While Bhardwaj et al. discloses gradual power change, the gradual power change is always associated with alternate application of etchant gas and deposition gas to the workpiece during formation of the feature, e.g., a trench.

(e) In addition, Bhardwaj et al. does not form a desired shape of a workpiece by converting a gas species into an AC etchant plasma that is always the dominant material applied to the workpiece, wherein the amount of AC power applied to the plasma during etching of the workpiece to form the desired shape gradually changes and a gradual transition in the shape of the material in the workpiece being processed occurs in response to the gradual power change that occurs during the gradual transition in the shape of the material.

5. An unobviousness aspect of the present invention over Bhardwaj et al. is that desired shapes can be formed by gradually changing plasma power without changing the gas species in the plasma. In Bhardwaj et al., the species are repeatedly changed from an etchant gas to a passivation gas during formation of a desired shape, e.g., walls of a trench. The present application, on page 3, lines 3-28, indicates the advantages of maintaining species constant while a desired shape is being formed. By practicing the method of the present invention, the problems of the prior art that Bhardwaj et al. were trying to overcome are avoided. This is because a true rounded corner is initially formed to prevent formation of the notches of Fig. 13, as described in column 8, lines 27-43. In addition, the method of the present invention is more efficient, more effectively controlled and is simpler to execute than the Bhardwaj et al. process because there is no need to switch between passivation and etchant gases.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine, or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

DATED this 17 day of May, 2007, at 18:30 Fremont, CA

Andrew D. Bailey III, Ph.D.